Preparation of Mesoporous and Macroporous Materials for SOFCs

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Various templates have been widely used for preparation of porous materials. Many kinds of supermolecular aggregates of surfactant molecules have been employed to create mesoporous materials. The pore size can be adjusted using surfactant aggregates with different lengths; however, the obtained pores are limited to about 30 nm in size. In order to achieve pores of up to a few hundreds of nanometers, solid colloidals are used as templates. In this study, a surfactant templating technique is used to prepare mesoporous materials and a solid-colloidal templating process is used to prepare macroporous materials for solid oxide fuel cells (SOFCs) applications.

Mesoporous YSZ-NiO stable upto 600 °C is prepared using dodecylbenzenesulfonic acid sodium salt as the structure-directing agent and the corresponding metal nitrates as precursors in an aqueous solution. Shown in Fig. 1 is a TEM image of mesoporous YSZ-NiO fired at 600 ^{o}C, revealing a mesoporous structure with an average pore size of 3.0 nm. X-ray diffraction of the fired powder shows the crystalline structure of YSZ and NiO. BET surface area analysis measurement shows that mesoporous YSZ-NiO has a surface area of 138 m^2/g with an average pore size of 2.8 nm.

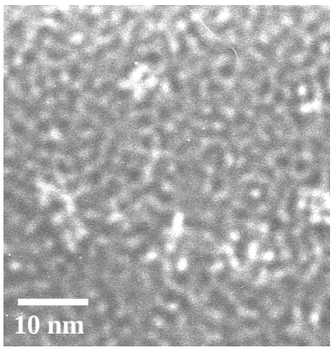

Fig. 1. A representative TEM image of mesoporous YSZ-NiO fired at 600 ^{o}C.

Mesoporous CeO_2 is prepared using hexadecyltrimethylammonium bromide as the structure-directing agent and ammonium cerium nitrate as precursor in an aqueous solution. After dried at 75 ^{o}C, small-angle x-ray diffraction reveals that it is ordered structure while wide-angle XRD indicates it is crystalline, as shown in Fig. 2.

Macroporous $Sr_{0.5}Sm_{0.5}CoO_3$ is prepared using polystyrene (PS) sphere templating process. Monodispersed PS suspension is first dried to PS powder. Then the dried PS powder is pressed into a pellet. A nitrate solution corresponding to the formula of $Sr_{0.5}Sm_{0.5}CoO_3$ is filled into the voids between spheres and condensed in air. After firing at 800 ^{o}C in air, PS is burned off and macroporous $Sr_{0.5}Sm_{0.5}CoO_3$ is formed. SEM image of the $Sr_{0.5}Sm_{0.5}CoO_3$ reveals macroporous structures, as shown in Fig. 3.

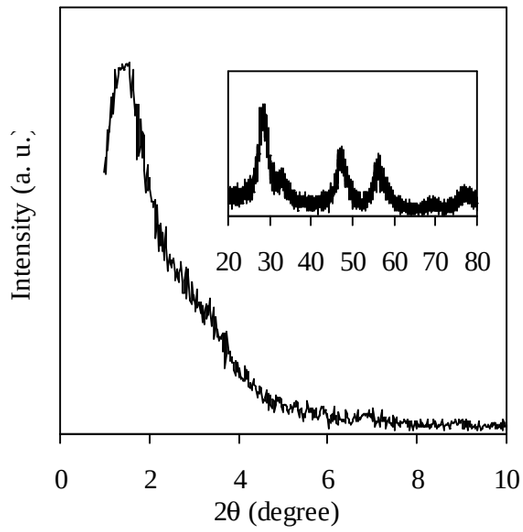

Fig. 2. A representative small-angle x-ray powder diffraction pattern of the as-synthesized CeO_2. The wide-angle x-ray diffraction pattern is shown in the inset.

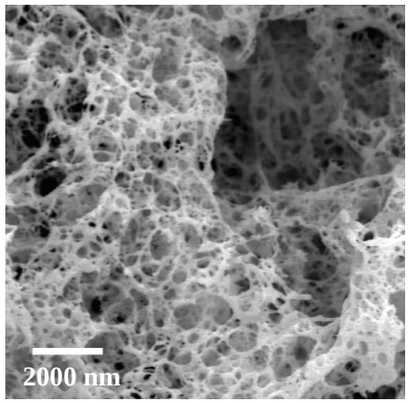

Fig. 3. A representative SEM image of macroporous $Sr_{0.5}Sm_{0.5}CoO_3$.

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